Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

The root-tubers of Isopyrum occidentale.

D. T. MAC DOUGAL.

Soon after my recent paper dealing with the physiology of the tubers of Isopyrum biternatum[1] had passed into the hands of the printer, I received a number of living plants of *I. occidentale* H. & A. from California, and the root-tubers were found to exhibit such marked characteristics that a special consideration of its anatomy was deemed advisable.

Since this species is confined to a limited area on the Pacific coast and is but little known in a living condition I append the following description.[2]

"Roots fascicled, fibrous: stem 6–10^{in} high, parted above into few one-flowered branches; leaflets 4–8 lines long, irregularly 3-lobed: pods short, sessile, obliquely pointed.—Under oaks, or other trees and shrubs, among the foothills on either side of the valley of the Sacramento."

The tubers are formed by the enlargement of the portions of the roots nearest the root-stock, .5 to 3^{cm} in length, resulting in the formation of a dense hemispherical cluster of spindle-shaped structures with a diameter of 1 to 4^{mm}. Pale gray and shining when young, they become brownish with age, due to the formation of oil-drops in the outer cortical layers. Although not verified by actual observation the tubers appear to live and increase in size for several years.

The structure of the root, which differs in many important features from that of *I. biternatum*, may be best understood by following its developmental history, which is in the earlier stages similar to that of *Ranunculus repens.*[3] The stele is generally tetrarchic and in normal roots the xylem bundles undergo a centripetal development resulting in the total obliteration of the medulla. The endodermis is soon clearly differentiated while the cortex is quite similar to that of *I. biternatum*, already described. In the thickening of such roots into tubers the medullary rays are developed internally in such manner that the xylem bundles are separated and a comparatively large central mass of parenchyma is formed. A cylindrical mass of the cells in the central portion of this tissue, extending the length of the tuber only, undergoes sclerosis to such an extent that the cell-lumina are almost obliterated, and the walls are simply pitted. These sclerotic cells are cylindrical in outline, are joined transversely at the ends, and their length is several times their diameter.

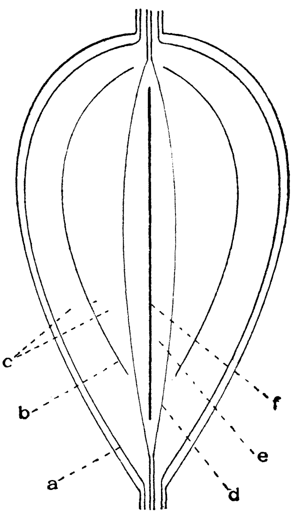
---

[1] A contribution to the physiology of the root-tubers of Isopyrum biternatum Torr. and Gray. Separate, March 31, 1896. Minn. Bot. Stud. **1**: 500–516. *pl. 28 and 29.* 1896.

[2] Greene, Flora Franciscana, part III. 308. 1892.

[3] Vines, Text Book of Botany 165. *fig. 127.* 1895.

A small bundle of secondary xylem is formed from each of the meristematic arches lying between the primary bundles. The larger part of the bulk of the tuber is due to the greatly accelerated development of the pericycle, resulting in the formation of a thick concentric ring of parenchymatous tissue, retaining in greater part its meristematic character, and differs from the corresponding region in *I. biternatum* in that it is furnished with numbers of small intercellular spaces. Extending to an indefinite distance from each primary bundle is a wedge shaped cambium ray. Near the cortex in the same plane as the rays are small bundles of elongated cells, which finally become woody, which have originated independently in the exaggerated pericycle. The cortex and endodermis show but little secondary change. In the latter an occasional newly formed radial wall may be seen.



Space is not at command for the proper citation of the numerous important papers bearing on the morphology of theroots of this group of the Ranunculaceæ, except to mention the work of Olivier[4] and Marie.[5]

In the comparison of the tubers of *I. biternatum* and *I. occidentale*, it can be seen that the formation of the tubers in both instances is due to the exaggerated development of the pericycle, and that the process in the first is accompanied by marked secondary changes in the endodermis and cortex, which do not occur in the root of either; in the second the development of the tuber is accompanied by the formation of secondary xylem bundles, and of a large medulla, the central portion of which undergoes a marked sclerosis: features entirely absent from the root. Further, the cambiform rays of *I. biternatum* are formed opposite the two secondary bundles and extend half the distance to the cortex terminating in a strand of woody cells originating in the pericycle, while in *I. occidentale* the cambiform rays are developed opposite the four or five primary bundles only, and extend only part way to the woody strands in the pericycle.

---

[4] Recherches sur l'appareil tegumentaire des racines. Ann. d. Sc. Nat. VI. **2**: —. —.

[5] Recherches sur la structure des Ranonculacees. Ann. d. Sci. Nat. VI. **20**: —. —.

So far as the physiological features of the tubers of the last named species have come under observation, they show a close similarity to those of the first. The parenchymatous cells from the tubers of plants beginning to bloom March 24th gave the globular aggregations on the application of strong alcohol. A few weeks later they contained numbers of granules reacting as "red starch." The cortical cells were also filled with reddish brown drops of oil, and the outer layer was infested with a number of hyphae. The presence of sclerenchyma in the medulla and in consequence in the tuber alone is somewhat remarkable, and seems entirely unexplainable by any of the accepted principles of mechanical induction; a fact more clearly apparent when it is remembered that the tubers are clustered in a compact mass in such position as to be incapable of receiving strains of any moment. Neither may inferences of value be deduced from a consideration of the absence, presence, or varying disposition of the sclerenchymatous tissues in the roots of the closely related genera.

University of Minnesota.